US009302269B2

(12) **United States Patent**
Anderson et al.

(10) **Patent No.: US 9,302,269 B2**
(45) **Date of Patent: Apr. 5, 2016**

(54) **SEED SAMPLING APPARATUS AND METHOD**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 298 days.

(21) Appl. No.: **14/233,506**

(22) PCT Filed: **Jul. 16, 2012**

(86) PCT No.: **PCT/US2012/046858**

§ 371 (c)(1),
(2), (4) Date: **Jan. 17, 2014**

(87) PCT Pub. No.: **WO2013/012778**

PCT Pub. Date: **Jan. 24, 2013**

(65) **Prior Publication Data**

US 2014/0166786 A1 Jun. 19, 2014

Related U.S. Application Data

(60) Provisional application No. 61/508,935, filed on Jul. 18, 2011.

(51) **Int. Cl.**
B02C 18/16 (2006.01)
G01N 1/28 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***B02C 18/16*** (2013.01); ***B02C 23/08*** (2013.01); ***B02C 23/18*** (2013.01); ***G01N 1/286*** (2013.01); ***G01N 33/0098*** (2013.01); *G01N 1/20* (2013.01); *G01N 2001/2021* (2013.01)

(58) **Field of Classification Search**
CPC B02C 18/16; B02C 23/18; B02C 23/08; B02C 9/04; B02C 13/288; B02C 13/00; G01N 33/0098; G01N 1/286; G01N 1/20; G01N 2001/2021
USPC 241/6–13, 19, 79.1, 101.8, 25
See application file for complete search history.

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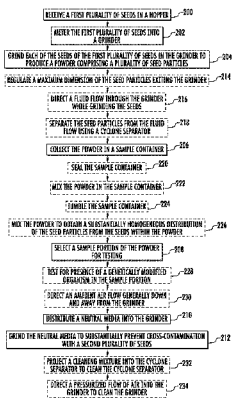
(57) **ABSTRACT**

An apparatus (**100**) configured to simultaneously sample a plurality of seeds is provided. The apparatus (**100**) may include a grinder (**110**) configured to grind each of the seeds of a first plurality of seeds to produce a powder comprising a plurality of seed particles. A sample container (**142**) may be configured to receive the powder. Further, a cleaning device may be configured to introduce a neutral media to the grinder (**110**) to substantially prevent cross-contamination with a second plurality of seeds, which may be ground thereafter. The apparatus (**100**) may further comprise a mixing device (**150**) configured to mix the powder. Thereby a sample portion of the powder may be tested for the presence of a genetically modified organism, or other tests may be conducted thereon. A related method for high throughput simultaneous sampling of a plurality of seeds is also provided.

14 Claims, 9 Drawing Sheets



(51) **Int. Cl.**

B02C 23/08	(2006.01)
B02C 23/18	(2006.01)
G01N 33/00	(2006.01)
G01N 1/20	(2006.01)

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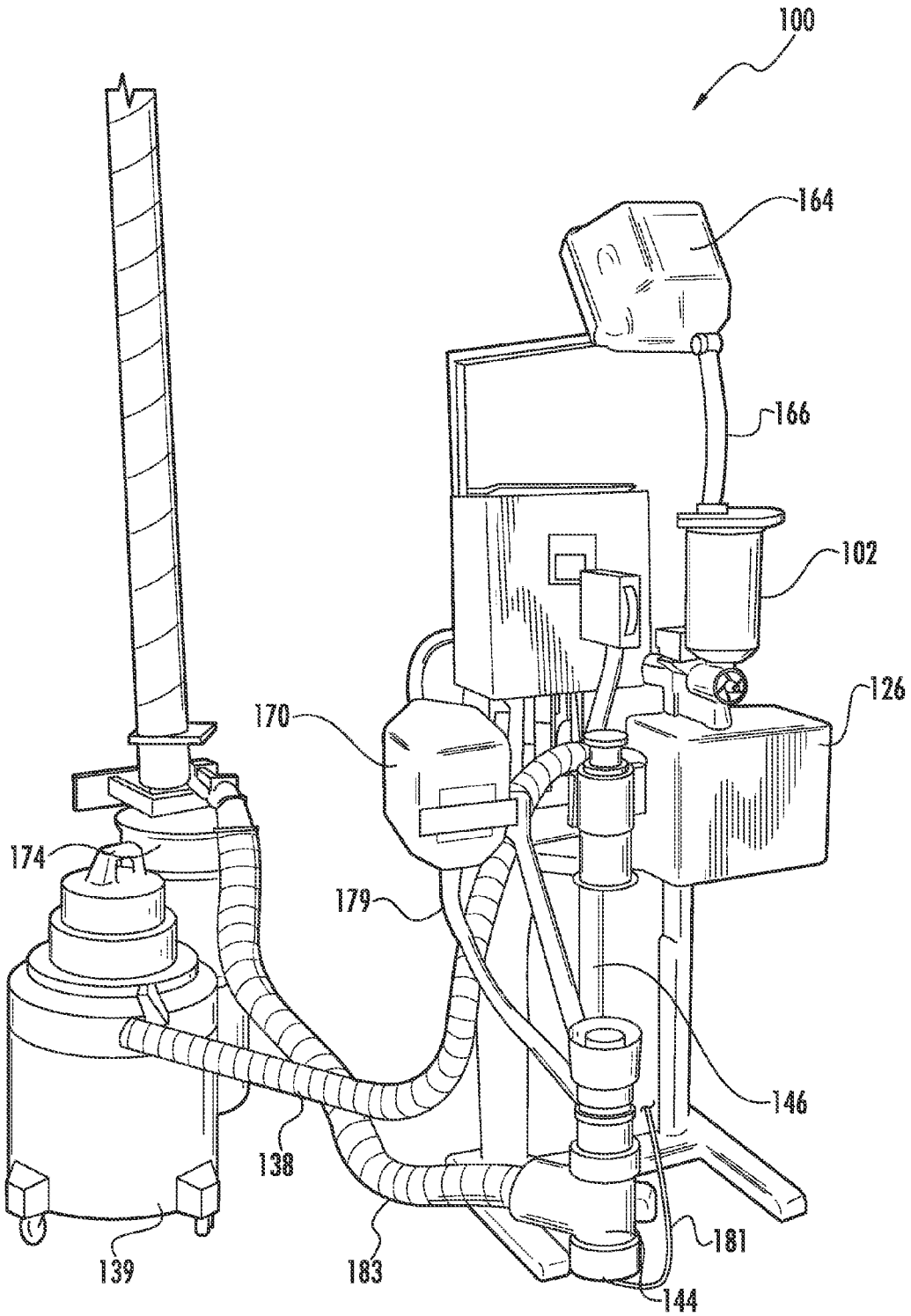

FIG. 1

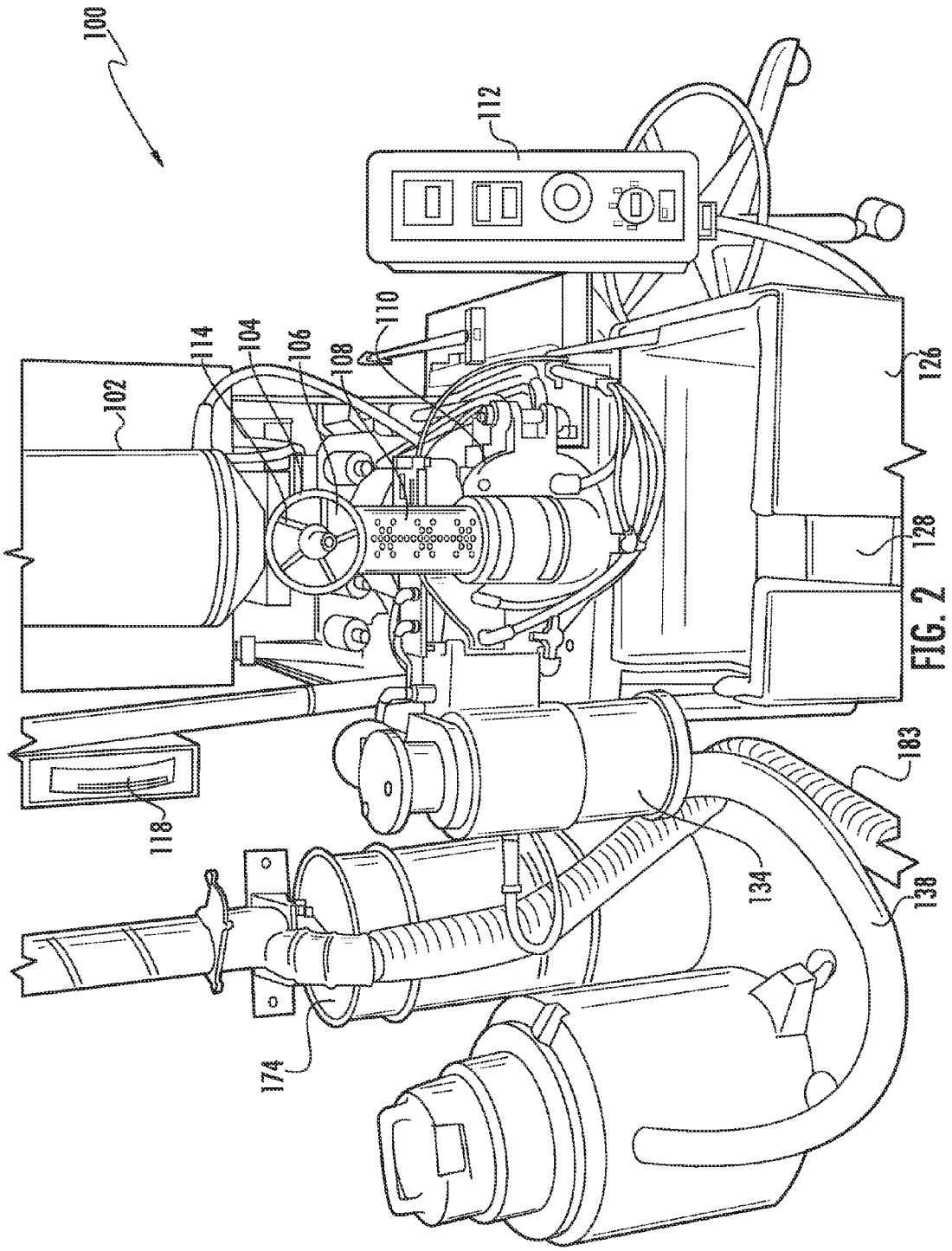

FIG. 2

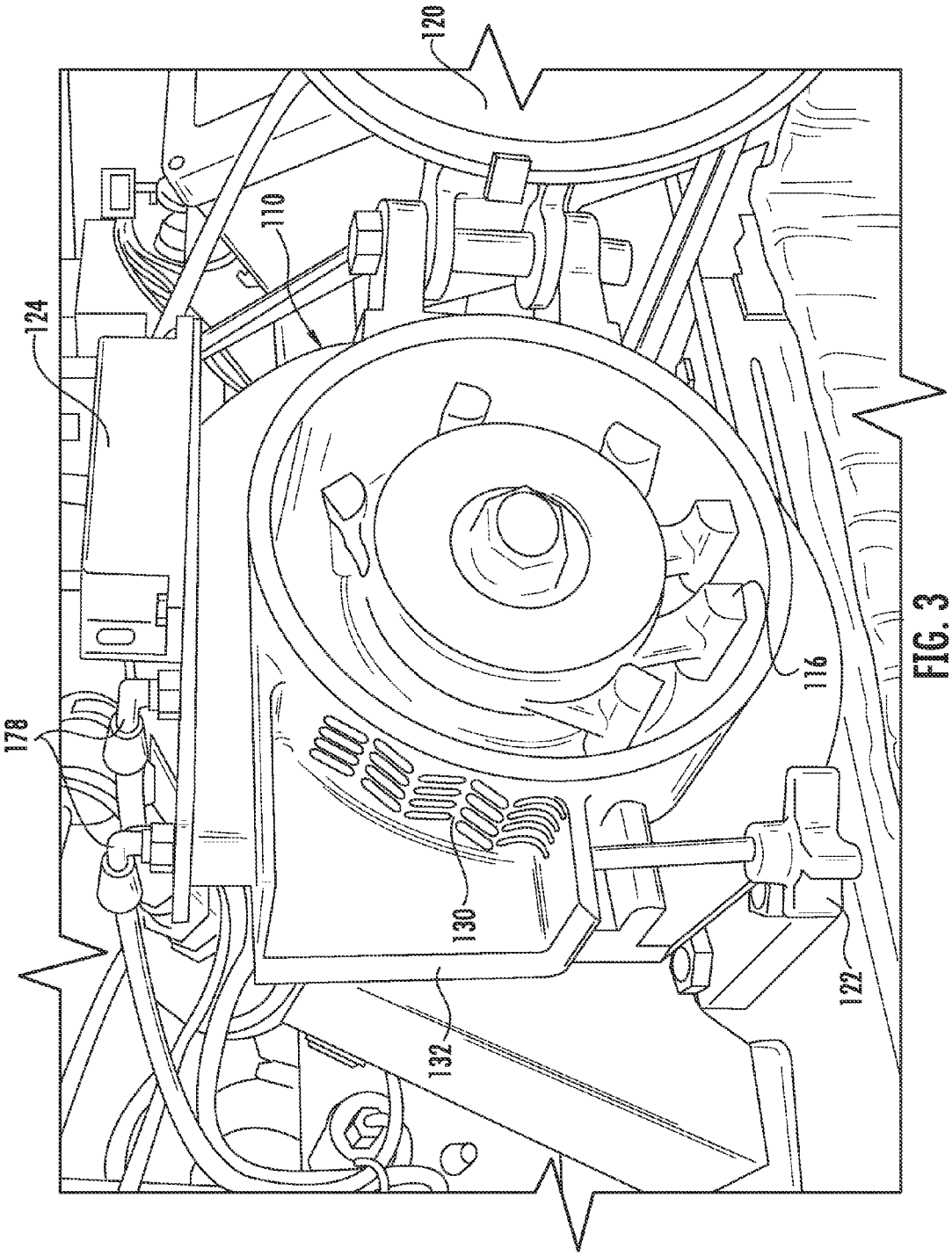

FIG. 3

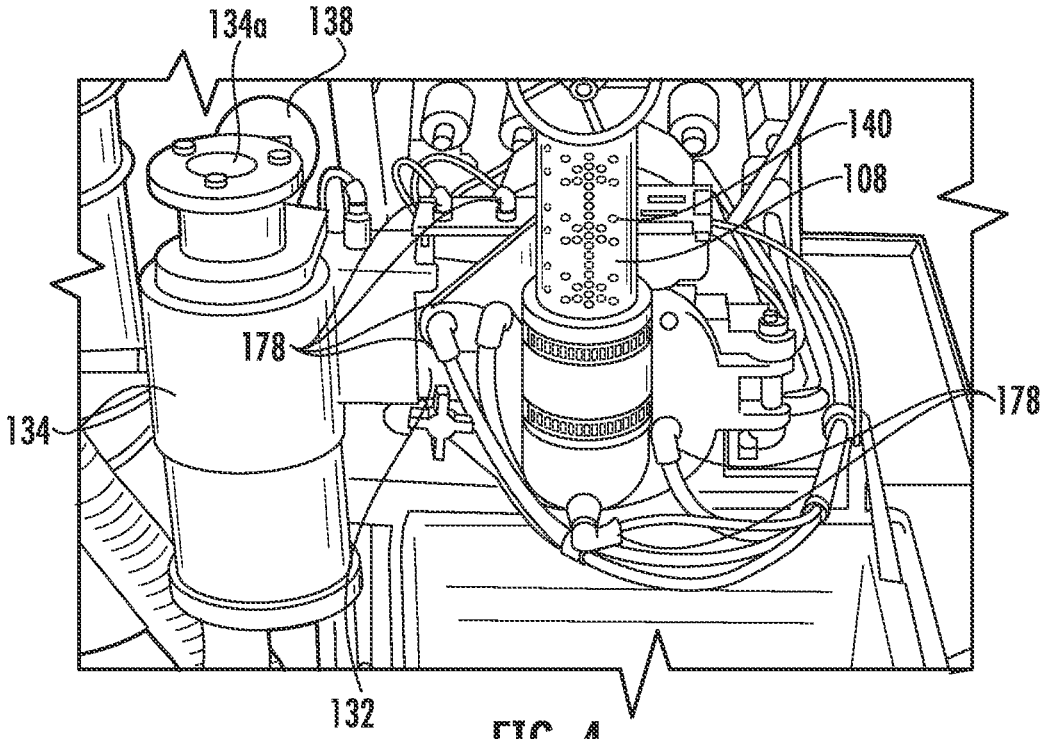

FIG. 4

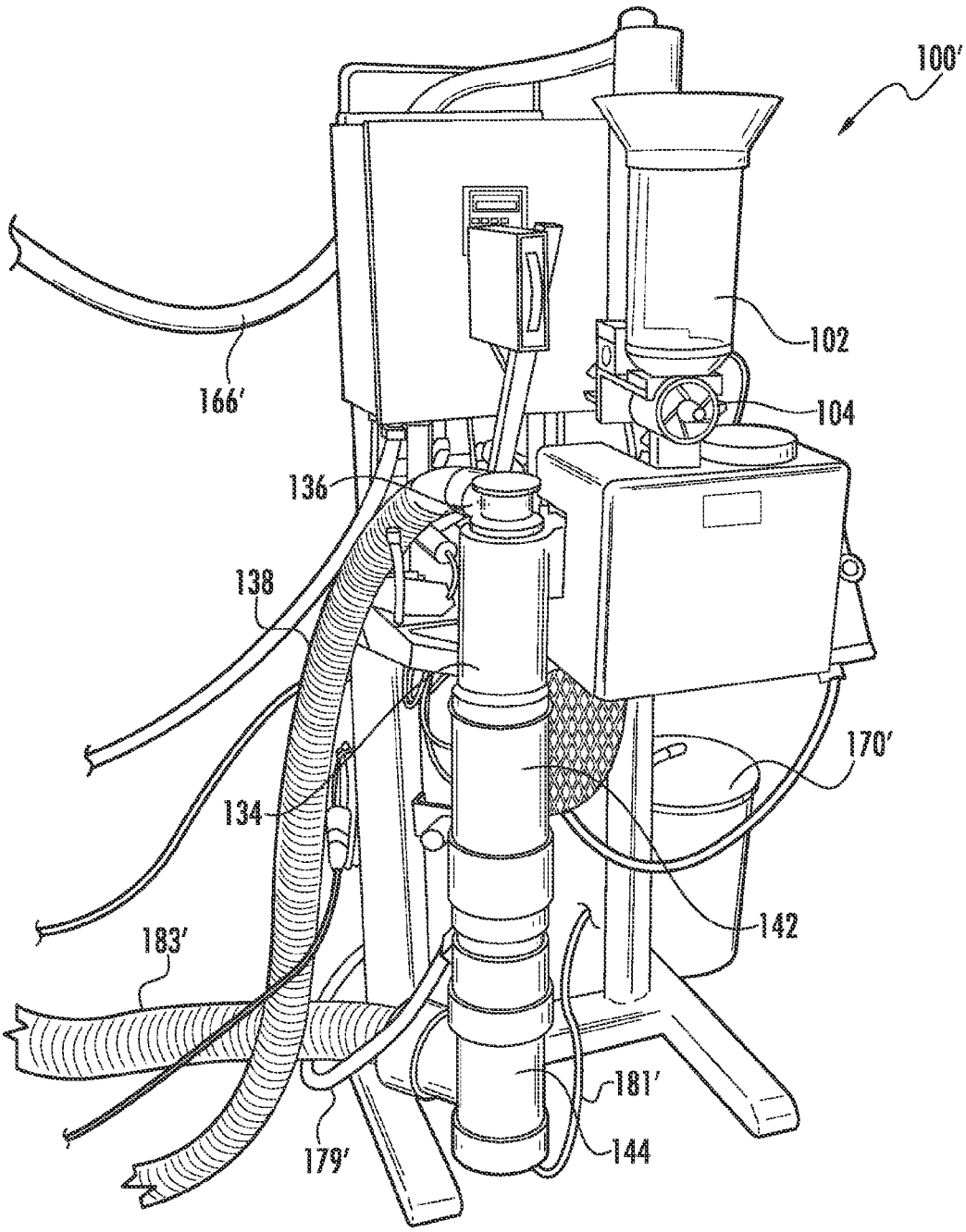

FIG. 5

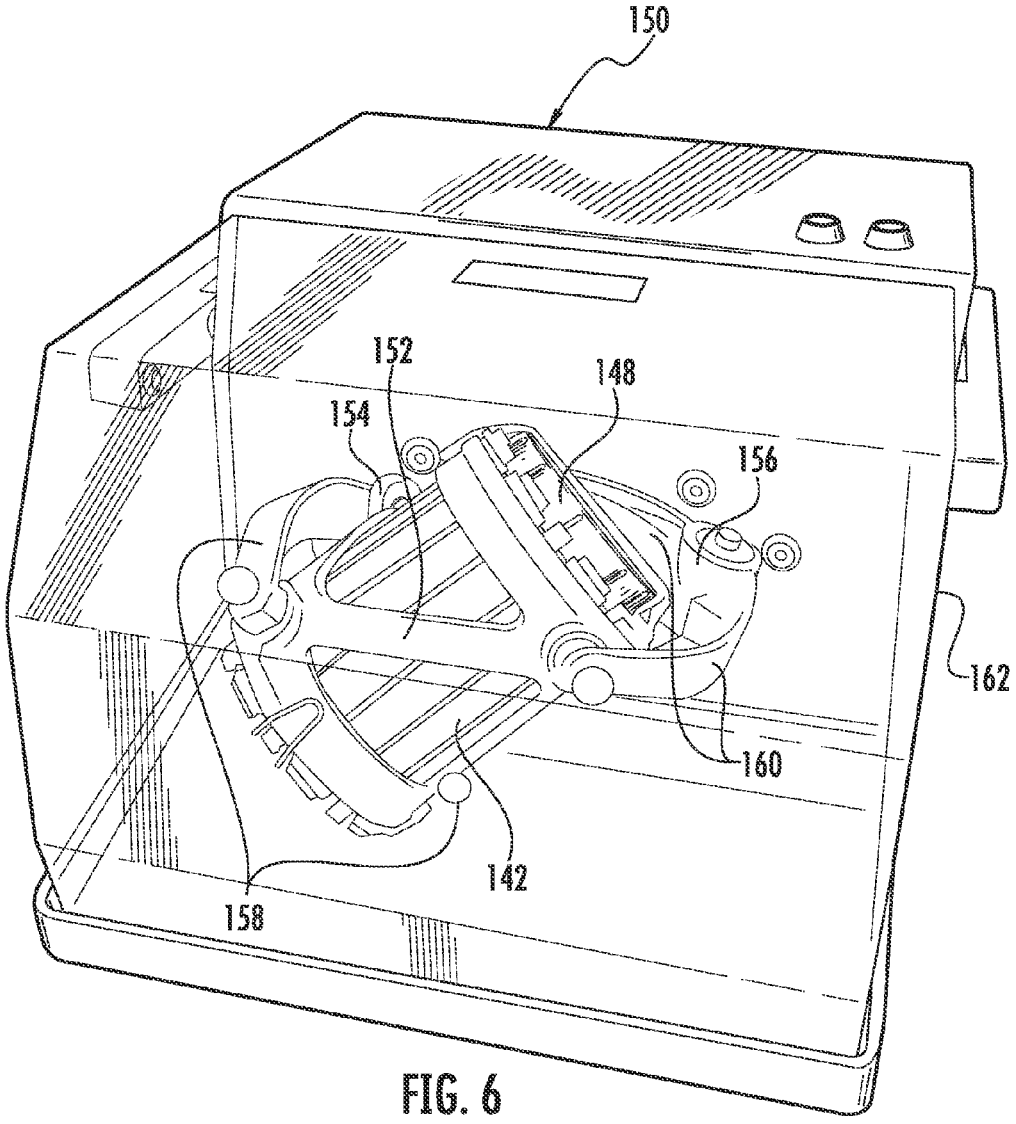

FIG. 6

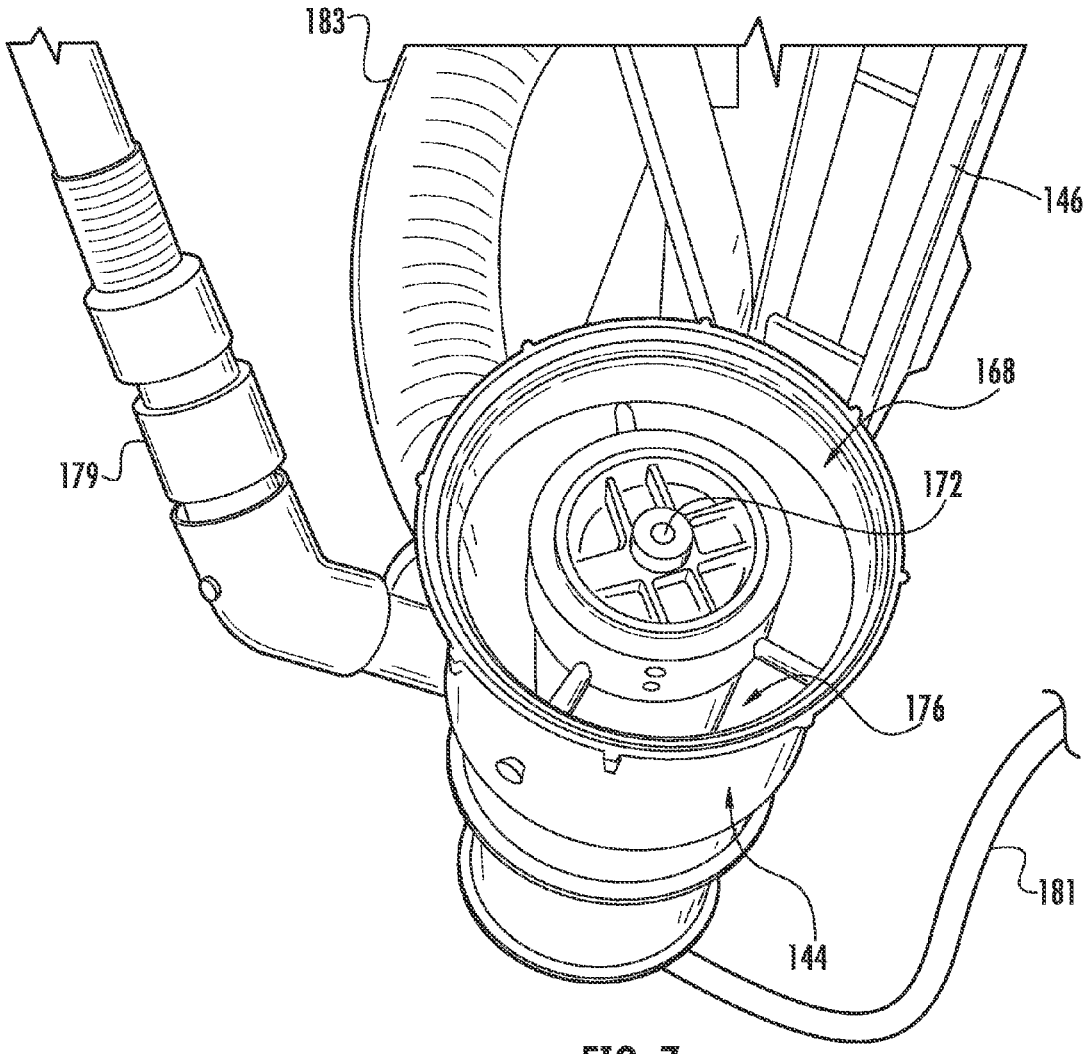

FIG. 7

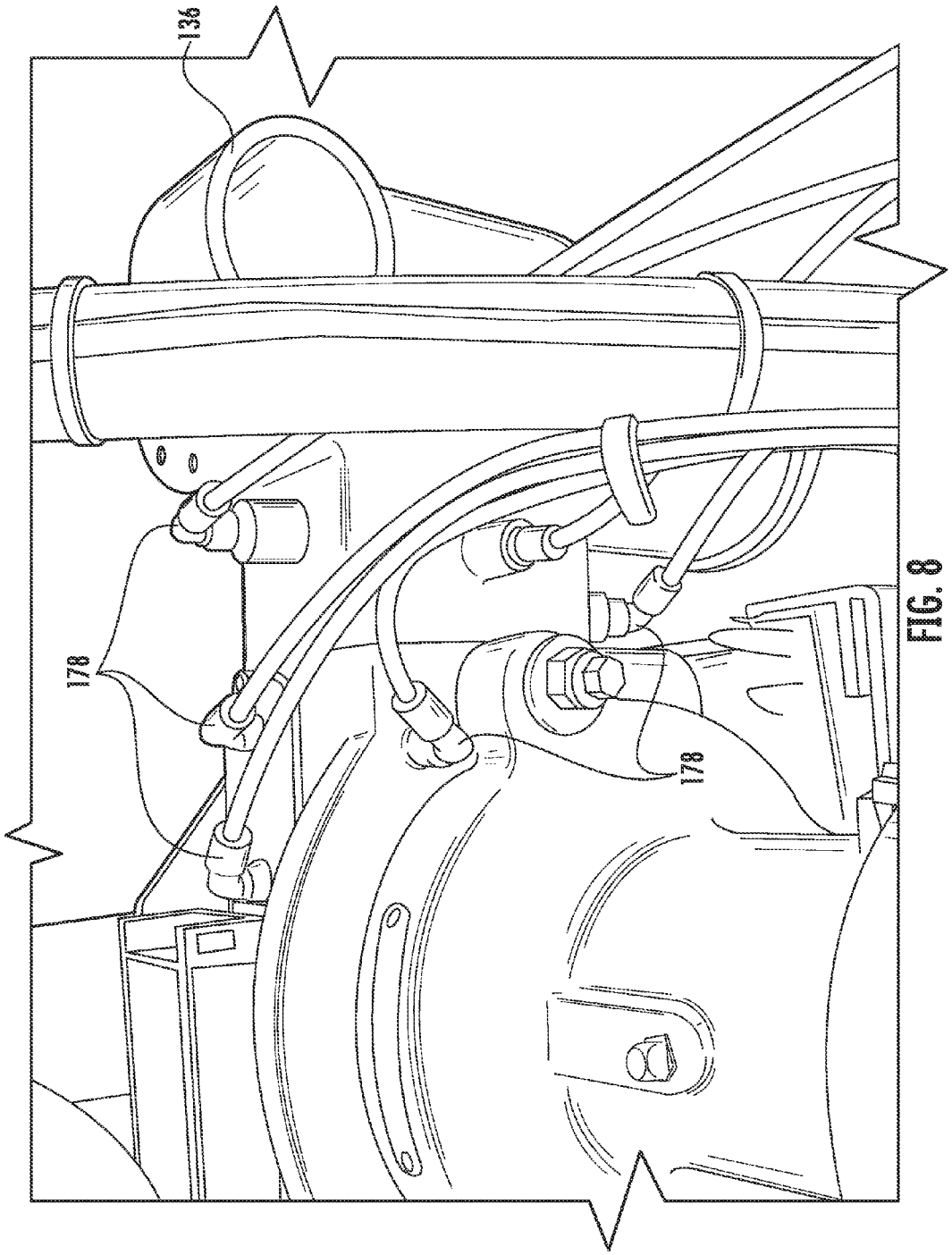

FIG. 8

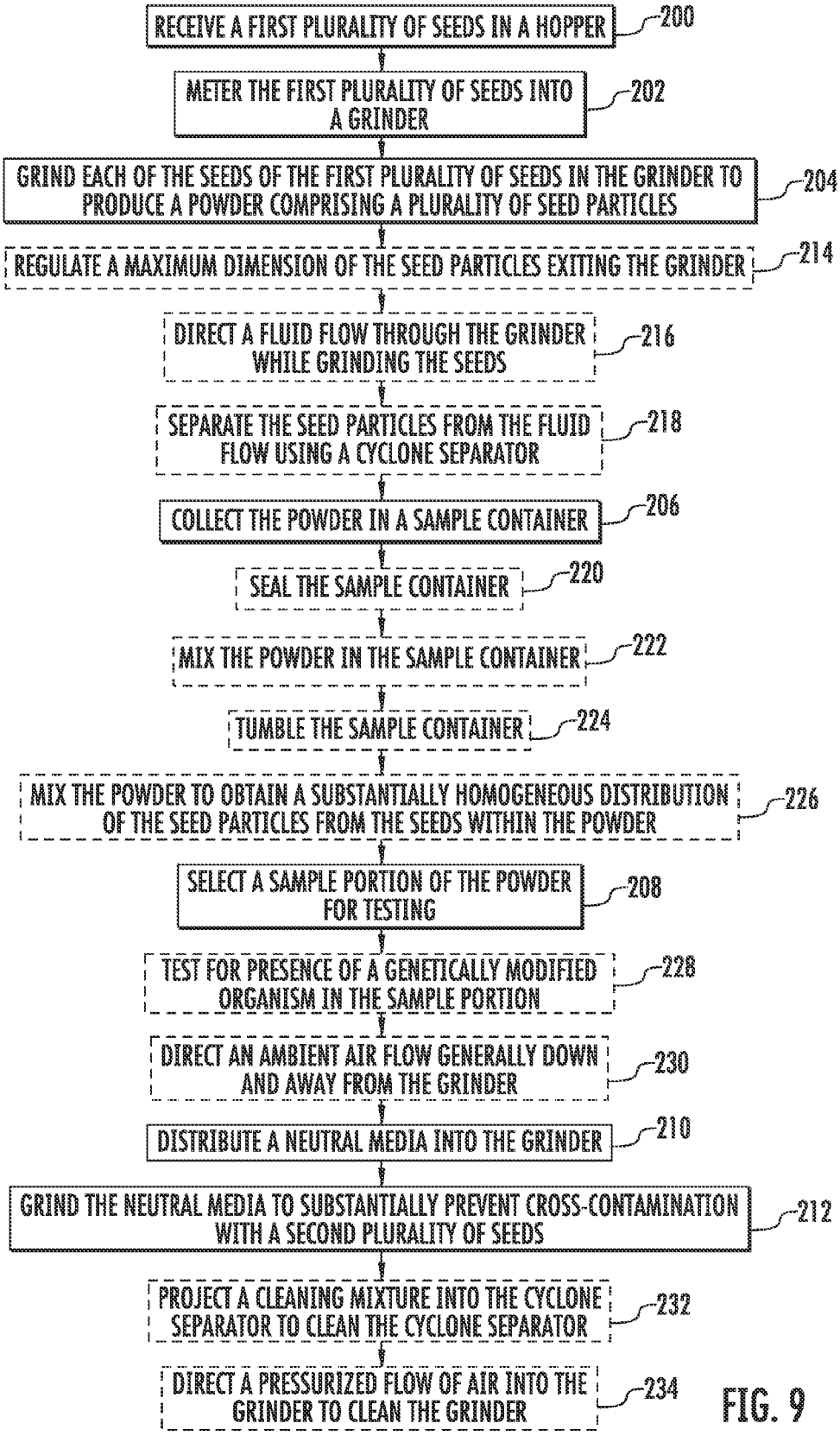
RECEIVE A FIRST PLURALITY OF SEEDS IN A HOPPER
200
METER THE FIRST PLURALITY OF SEEDS INTO A GRINDER
202
GRIND EACH OF THE SEEDS OF THE FIRST PLURALITY OF SEEDS IN THE GRINDER TO PRODUCE A POWDER COMPRISING A PLURALITY OF SEED PARTICLES
204
REGULATE A MAXIMUM DIMENSION OF THE SEED PARTICLES EXITING THE GRINDER
214
DIRECT A FLUID FLOW THROUGH THE GRINDER WHILE GRINDING THE SEEDS
216
SEPARATE THE SEED PARTICLES FROM THE FLUID FLOW USING A CYCLONE SEPARATOR
218
COLLECT THE POWDER IN A SAMPLE CONTAINER
206
SEAL THE SAMPLE CONTAINER
220
MIX THE POWDER IN THE SAMPLE CONTAINER
222
TUMBLE THE SAMPLE CONTAINER
224
MIX THE POWDER TO OBTAIN A SUBSTANTIALLY HOMOGENEOUS DISTRIBUTION OF THE SEED PARTICLES FROM THE SEEDS WITHIN THE POWDER
226
SELECT A SAMPLE PORTION OF THE POWDER FOR TESTING
208
TEST FOR PRESENCE OF A GENETICALLY MODIFIED ORGANISM IN THE SAMPLE PORTION
228
DIRECT AN AMBIENT AIR FLOW GENERALLY DOWN AND AWAY FROM THE GRINDER
230
DISTRIBUTE A NEUTRAL MEDIA INTO THE GRINDER
210
GRIND THE NEUTRAL MEDIA TO SUBSTANTIALLY PREVENT CROSS-CONTAMINATION WITH A SECOND PLURALITY OF SEEDS
212
PROJECT A CLEANING MIXTURE INTO THE CYCLONE SEPARATOR TO CLEAN THE CYCLONE SEPARATOR
232
DIRECT A PRESSURIZED FLOW OF AIR INTO THE GRINDER TO CLEAN THE GRINDER
234

FIG. 9

SEED SAMPLING APPARATUS AND METHOD

FIELD OF THE INVENTION

Various embodiments of the present invention relate generally to an apparatus and method for sampling seeds. More specifically, embodiments of the present invention provide an apparatus and method configured to simultaneously sample a plurality of seeds while substantially preventing cross-contamination.

BACKGROUND OF THE INVENTION

In the production of seed, testing may be required to determine the purity of the seed or other attributes thereof. For example, various rules and regulations may prohibit the inclusion of genetically modified organisms ("GMOs") in seed sold for agricultural purposes. Accordingly, the seed may need to be tested to verify compliance with the rules and regulations.

However, individually sampling seeds is virtually impossible given the vast numbers of seeds which may be distributed to farmers. Thus, simultaneous sampling of seeds by processing the seeds and testing the seeds at the same time may represent a viable alternative to individually sampling seeds. However, while bulk sampling may overcome issues with respect to processing large quantities of seed, additional issues may arise.

BRIEF SUMMARY

In one embodiment a method for high throughput simultaneous sampling of a plurality of seeds is provided. The method may include receiving a first plurality of seeds in a hopper, metering the first plurality of seeds into a grinder, and grinding each of the seeds of the first plurality of seeds in the grinder to produce a powder comprising a plurality of seed particles. The method may further include collecting the powder in a sample container and selecting a sample portion of the powder for testing. Additionally, the method may include distributing a neutral media into the grinder and grinding the neutral media to substantially prevent cross-contamination with a second plurality of seeds.

In some embodiments the method may further comprise regulating a maximum dimension of the seed particles exiting the grinder. Also, the method may include mixing the powder to obtain a substantially homogeneous distribution of the seed particles from the seeds within the powder. Additionally, the method may comprise sealing the sample container and mixing the powder in the sample container. Further, the method may include tumbling the sample container.

In some embodiments the method may also comprise directing a fluid flow through the grinder while grinding the seeds and separating the seed particles from the fluid flow using a cyclone separator. Additionally, the method may include projecting a cleaning mixture into the cyclone separator to clean the cyclone separator. The cleaning mixture may comprise the neutral media in some embodiments. Also, the neutral media may comprise a granulated plastic material or a plurality of control seeds which do not comprise a genetically modified organism in some embodiments. Additionally, in some embodiments grinding the neutral media may be conducted prior to grinding the seeds of the first plurality of seeds.

In some embodiments the method may additionally comprise directing an ambient air flow generally down and away from the grinder. Further, the method may include directing a pressurized flow of air into the grinder to clean the grinder. Also, the method may comprise testing for presence of a genetically modified organism in the sample portion.

In an additional embodiment an apparatus configured to simultaneously sample a plurality of seeds is provided. The apparatus may include a grinder configured to grind each of the seeds of a first plurality of seeds to produce a powder comprising a plurality of seed particles. A sample container may be configured to receive the powder. Further, a cleaning system may be configured to introduce a neutral media to the grinder to substantially prevent cross-contamination with a second plurality of seeds.

In some embodiments the apparatus may further comprise a control unit configured to maintain a substantially constant load on a motor driving the grinder. Further, a cyclone separator may be configured to separate the seed particles from a fluid flow. The cleaning system may be configured to project a cleaning mixture into the cyclone separator to clean the cyclone separator. The apparatus may additionally include a mixing device configured to mix the powder to obtain a substantially homogeneous distribution of the seed particles from the seeds within the powder. Also, a lid may be configured to seal the sample container, wherein the mixing device is configured to tumble the sample container while the sample container is sealed.

In some embodiments the apparatus may further include a metering device configured to meter the seeds into the grinder. Additionally, a screen may be configured to regulate a maximum dimension of the seed particles exiting the grinder. The cleaning system may comprise one or more air jets configured to direct a pressurized flow of air into the grinder to clean the grinder. Additionally, a negative air flow system may be configured to direct an ambient air flow generally down and away from the grinder. Also, in some embodiments the sample container may be further configured to store the first plurality of seeds before the first plurality of seeds are ground into the powder.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING(S)

Having thus described the invention in general terms, reference will now be made to the accompanying drawings, which are not necessarily drawn to scale, and wherein:

FIG. **1** illustrates an embodiment of an apparatus configured to simultaneously sample a plurality of seeds in accordance with an example embodiment of the present invention;

FIG. **2** illustrates an enlarged view of a seed hopper and grinder of the apparatus of FIG. **1** in accordance with an example embodiment of the present invention;

FIG. **3** illustrates an enlarged view of the inside of the grinder illustrated in FIG. **2** in accordance with an example embodiment of the present invention;

FIG. **4** illustrates an enlarged view of a cyclone separator of the apparatus of FIG. **1** in accordance with an example embodiment of the present invention;

FIG. **5** illustrates a modified version of the apparatus of FIG. **1** with a remotely located neutral media source in accordance with an example embodiment of the present invention;

FIG. **6** illustrates a sample container in a mixing device in accordance with an example embodiment of the present invention;

FIG. **7** illustrates an enlarged view of a support member of the apparatus of FIG. **1** in accordance with an example embodiment of the present invention;

FIG. **8** illustrates an enlarged rear view of air jets of the apparatus of FIG. **1** in accordance with an example embodiment of the present invention; and

FIG. **9** illustrates a method for high throughput simultaneous sampling of a plurality of seeds in accordance with an example embodiment of the present invention.

DETAILED DESCRIPTION

The present invention now will be described more fully hereinafter with reference to the accompanying drawings, in which some, but not all embodiments of the invention are shown. Indeed, the invention may be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will satisfy applicable legal requirements. Like numbers refer to like elements throughout.

One embodiment of an apparatus **100** configured to simultaneously sample a plurality of seeds is illustrated in FIG. **1**. The apparatus **100** may comprise a seed hopper **102** configured to receive and hold seeds which are to be sampled. The seed hopper **102** may comprise a translucent or transparent material such as glass or plastic which allows an operator to view the seeds within the seed hopper. As illustrated in FIG. **2**, the seed hopper **102** may be coupled to a metering device **104**. The metering device **104** may comprise a viewing panel **106** on the front which may also be formed from a translucent or transparent material such as glass or plastic.

In this regard, the metering device **104** may be configured to meter the seeds through a connecting tube **108** to a grinder **110**. Use of a transparent or translucent seed hopper **102** and viewing panel **106** on the metering device **104** may allow the operator to view the seeds and know when all of the seeds from the seed hopper have been metered through the metering device to the grinder **110**. In some embodiments of the apparatus **100** the metering device **104** may be hand operated. For example the user may rotate a crank to operate the metering device **104** and meter the seeds into the grinder **110** at a desired rate. However, the illustrated embodiment the apparatus **100** comprises a control unit **112** which may be configured to control the metering device **104** and meter the seeds into the grinder **110** at a desired rate. The metering device **104** may comprise a plurality of paddles **114** between which the seeds fall from the seed hopper **102** when the metering device is rotated. Thereby, relatively consistent quantities of the seeds may be delivered to the grinder **110** from between the paddles **114** as the metering device **104** rotates.

One embodiment of the grinder **110** is illustrated in FIG. **3**. The illustrated embodiment of the grinder **110** comprises a hammer mill grinder, although various other embodiments of grinders may be employed in alternate embodiments of the apparatus **100** as would be understood by one having skill in the art. The grinder **110** may comprise a plurality of hammers **116** which rotate and swing as the grinder operates. Thereby, the hammers **116** grind the seeds which are delivered to the grinder **110** by the metering device **104**.

As noted above, the metering device **104** meters the seeds into the grinder **110**. Metering the seeds into the grinder **110** may be employed to control the amount of seeds which are in the grinder at any one time. For example, the grinder **110** may have a limited capacity which limits the number of seeds which may be received. Further, the grinder **110** may have to exert additional effort when more seeds are received.

In this regard, as illustrated in FIG. **2**, the apparatus **100** may comprise an amperage gauge **118** which outputs an amperage reading corresponding to the load on a motor driving the grinder **110**. In embodiments employing a hand crank or other embodiment of a manual metering device, the operator may view the reading on the amperage gauge **118** to determine when and/or at what rate to meter seeds into the grinder **110**. For example, the operator may attempt to maintain a constant amperage reading and/or prevent the amperage reading from exceeding a threshold value.

In embodiments wherein the control unit **112** controls the metering device, the control unit may receive a signal from the amperage gauge **118** indicating the amperage draw by the motor and thereby the control unit may automatically maintain a constant amperage draw and/or prevent the amperage draw from exceeding a threshold value. Accordingly, by maintaining a substantially constant load on the motor, as reflected by a substantially constant amperage draw, the longevity of the motor driving the grinder **110** may be increased and the seeds may be ground more consistently.

Returning to FIG. **3**, it should be noted that the grinder **110** is illustrated with a grinder door **120** in an open configuration. However, the grinder door **120** will normally be closed during operation. In this regard, the grinder door **120** may retain the seeds within the grinder **110** and prevent the seeds from spilling out of the grinder and also prevent access to the hammers **116** during operation, which may otherwise present a safety hazard. Accordingly, the grinder **110** may further comprise a locking mechanism **122** which may secure the grinder door **120** in a closed configuration (see, e.g., FIG. **2**), whereby the grinder door is substantially locked in place. However, to further ensure that the grinder door **120** is fully closed prior to and during operation, the apparatus **100** may additionally comprise a safety switch **124**. The safety switch **124** may be configured to detect whether or not the grinder door **120** is in the closed configuration and output a signal indicating whether the grinder door is in the closed configuration. Accordingly, the control unit **112** may be configured to prevent and/or stop operation of the grinder **110** in the event that the safety switch **124** indicates that the grinder door **120** is not in the closed configuration.

With further regard to safety, as illustrated in FIG. **1**, the apparatus **100** may comprise a shield **126** which is positioned about the grinder **110** during operation thereof. The shield **126** may be configured to reduce noise emissions and/or prevent access to the grinder. With regard to reduction of noise emissions, as illustrated in FIG. **2**, the shield **126** may comprise a liner **128** which is configured to absorb and/or reflect sound so as to reduce the amount of sound exiting through the shield. Accordingly, noise emissions encountered by an operator may be reduced. Further, the shield **126** may be configured to function as a blast shield which may protect the operator in the event that the grinder **110** experiences a mechanical malfunction.

As noted above, the grinder **110** may be configured to grind each of the seeds received therein to produce a powder comprising a plurality of seeds particles. As will be described below, grinding the seeds into seed particles may allow for testing of each of the ground seeds at the same time by taking advantage of the particle size. Accordingly, it may be desirable to grind the seeds such that the particles comprising the powder are below a threshold size. Thus, the apparatus **100** may comprise a screen **130** configured to regulate a maximum dimension of the seed particles exiting the grinder **110**. The screen **130** may be configured to comprise openings which define the maximum dimension of the seed particles which travel therethrough. Accordingly, seeds may circulate and continue to be ground by the grinder **110** until the seed particles define a dimension which is smaller than the size of the openings. Thereby, the seed particles exiting the grinder **110**

may be of relatively consistent dimensions which are below the maximum dimension as regulated by the screen **130**.

After the seed particles comprising the powder exit the grinder **110** through the screen **130**, the seed particles may be collected in a sample container. A sample container may in some embodiments directly couple to an outlet **132** of the grinder **110** to receive the powder. However, in the illustrated embodiment the apparatus **100** further comprises a cyclone separator **134**. As illustrated in FIG. **4**, the cyclone separator **134** may couple to the outlet **132** of the grinder **110** to receive the powder exiting therefrom. The cyclone separator **134** is configured to separate the seed particles comprising the powder from a fluid flow. In this regard, the cyclone separator **134** may comprise an air outlet **136** (see, e.g. FIG. **8**) through which a fluid flow is directed. For example, as illustrated in FIG. **2**, a suction hose **138** may couple to the air outlet **136** of the cyclone separator **134**. The suction hose **138** may also couple to a vacuum source **139** (see, e.g. FIG. **1**) which produces the flow of air through the apparatus **100**. By pulling air through the grinder **110** and separating the particles from the flow of air with the cyclone separator **134**, the seed particles may be more effectively removed from the grinder during operation.

In this regard, as illustrated in FIG. **4**, the connecting tube **108** may comprise a plurality of inlet holes **140** through which air enters and travels into the grinder **110** as a result of the vacuum applied to the cyclone separator **134** by the vacuum source **139** through the suction hose **138**. The fluid flow thereby travels from the connecting tube **108** through the grinder **110** and into the cyclone separator **134**. The fluid flow may pick up seed particles and direct the seed particles through the screen **130** when they are small enough to travel therethrough. Accordingly, the fluid flow may carry therewith a plurality of seed particles when entering the cyclone separator **134**. The cyclone separator **134** may direct the fluid flow so as to create a cyclone or vortex whereby the seed particles may tend to fall out of the fluid flow. Thereby a flow of relatively clean air may be directed through the air outlet **136** and suction hose **138** to the vacuum source **139** whereas the seed particles may fall downwardly.

Accordingly, as illustrated in FIG. **5** (which illustrates a slightly modified embodiment of the apparatus **100'**, as will be discussed below), the cyclone separator **134** may be configured to couple to a sample container **142**. The sample container **142** may thereby receive the seed particles which fall from the fluid flow. Accordingly, the seeds which initially enter the seed hopper **102** may ultimately be captured in the sample container **142** in the form of a powder comprising seed particles. The sample container **142** may be held in place so as to be coupled to the cyclone separator **134** by a support member **144**. The support member **144** may be configured to translate on a track **146** (see, e.g. FIG. **1**). In some embodiments the track **146** may comprise a pneumatic cylinder or other force producing means configured to move the sample container **142** so as to couple with the cyclone separator **134**. Accordingly, the support member **144** may assist the sample container **142** in receiving the seed particles comprising the powder. Once all of the seeds have been metered into the grinder **110** by the seed metering device **104**, and substantially all of the seed particles have exited the grinder, the support member **144** may lower on the track **146** so as allow the operator to retrieve the sample container **142**.

As illustrated in FIG. **6**, after the sample container **142** is retrieved, the operator may secure a lid **148** configured to seal the sample container. Thereafter, the powder comprising the plurality of seed particles may be mixed. In this regard, FIG. **6** further illustrates a mixing device **150** configured to mix the powder to obtain a substantially homogeneous distribution of the seed particles from the seeds within the powder. The mixing device **150** may comprise the TURBULA® Mixer-Shaker as sold by GLEN MILLS®, Inc. of Clifton, N.J. in some embodiments. The mixing device **150** may comprise a container holder **152** which is configured to receive and hold the sample container **142**. First **154** and second **156** rotating members may each attach to opposite ends of the container holder **152** through unequal length arms **158**, **160**. When the rotating members **154**, **156** rotate, the mixing device **150** may produce a tumbling effect as a result of the unequal length arms **158**, **160**. A protective lid **162** may be lowered when the mixing device **150** is in operation in order to prevent contact between the moving parts and the operator of the mixing device.

As described above, the mixing device **150** in the illustrated embodiment may be configured to mix the powder by tumbling the powder while the sample container **142** is sealed by the lid **148**. Thus, for example, after the sample container **142** is removed from the cyclone separator **134**, the lid **148** may be secured to the sample container, and then the sample container may be tumbled by the mixing device **150** without having to remove the powder from the sample container. Accordingly, the potential for contamination of the powder may be reduced. However, as may be understood by one having skill in the art, various embodiments of sample containers and corresponding mixing devices may be configured to mix the powder by tumbling or otherwise agitating the powder.

Once the powder is mixed, an operator may take a sample portion from the powder and conduct tests thereon. Due to the grinding of the seeds into a powder comprising a plurality of seed particles and mixing of the powder, the size of the sample portion needed to test each of the seeds may be less than the entirety of the powder produced from the seeds. In particular, the small size of the particles and the mixing thereof may produce a substantially homogeneous distribution of the particles such that even a relatively small sample portion may comprise at least one particle from each of the seeds which are ground.

Any of a variety of tests may be performed on the sample portion depending on what information is desired to be obtained from the sample. For example, in one embodiment the sample may be tested for presence of a GMO in the sample portion. Thus, a large quantity of seed product may be verified to be free of GMOs through testing of a relatively small number of seeds. However, as may be understood by one having skill in the art, various other tests may be conducted on the sample portion of the seed product.

As noted above, collecting and mixing the powder in the same sample container **142** may reduce the potential for cross-contamination. However, embodiments of the present invention may comprise additional features configured to reduce the probability of cross-contamination. In this regard, the apparatus **100** may comprise a cleaning system configured to introduce a neutral media to the grinder **110** to substantially prevent cross-contamination with a second plurality of seeds. The cleaning system may be distributed throughout various portions of the apparatus **100** in some embodiments.

For example, as illustrated in FIG. **1**, a neutral media source **164** may be configured to introduce neutral media through a feed hose **166** into the seed hopper **102**, which may then be metered into the grinder **110** using the metering device **104**. Thus, the neutral media may be fed by gravity to the seed hopper **102** in some embodiments. In an alternate embodiment of the apparatus **100'**, as illustrated in FIG. **5**, the neutral

media may be stored in a remote location and directed to the seed hopper **102**. Thereby, for example, a large quantity of the neutral media may be stored in a container at an alternate location, rather than positioned on top of the seed hopper **102**, as illustrated in FIG. **1**. When positioned remotely, the neutral media may be directed to the seed hopper **102** through a feed hose **166'**. In one embodiment the neutral media may be agitated and directed through the feed hose **166'** using a flow of compressed air.

Regardless of where the neutral media is stored, it may be directed to the seed hopper **102** (or directly to the grinder **110** in some embodiments). The neutral media may be configured to contact and remove any particles remaining from a plurality of seeds which have been processed by the apparatus **100**. Thus, in some embodiments the neutral media may comprise a granulated plastic material. For example, the neutral media may comprise AERO-CLEAN® plastic blast media, as sold by MAXI-BLAST® Inc, of South Bend, Ind. Thus, after a first plurality of seeds are processed by the apparatus **100**, the neutral media may be introduced into the seed hopper **102**. The metering device **104** may then be operated so as to meter the seeds into the grinder **110**. By depositing the neutral media into the seed hopper **102** and directing it through the metering device **104**, the neutral media may contact and dislodge seed particles which may have been left by the first plurality of seeds as they traveled therethrough. Once the neutral media is introduced into the grinder **110**, the neutral media may be ground by the grinder and the grinding operation may remove seed particles left behind by the seeds in the grinder.

However, in other embodiments the neutral media may comprise a plurality of control seeds which do not comprise a GMO. For example, this type of neutral media may be used when testing for the present of a GMO, as described above. By directing the control seeds through the seed hopper **102**, the metering device **104**, and the grinder **110**, the control seeds may be ground and the resulting seed particles may fill in any gaps in the grinder and other depressions, holes and areas into which seed particles may deposit. Accordingly, the control seeds may deposit a barrier of known seed particles which may further assist in preventing cross-contamination with a second plurality of seeds which are processed after a first plurality of seeds. In some embodiments the operation of grinding the control seeds may be conducted prior to grinding the seeds of the first plurality of seeds. For example, the control seeds may be directed through the apparatus **100** as an initial matter before processing any seeds for testing purposes. However, in other embodiments the control seeds may be ground between processing of a first plurality of seeds and a second plurality of seeds, as described above with respect to use of a neutral media comprising plastic.

Additionally or alternatively, the cleaning system may be configured to project a cleaning mixture into the cyclone separator **134** to clean the cyclone separator. The cleaning mixture may comprise the neutral media in some embodiments. Therefore, for example, the cleaning mixture may comprise granulated plastic in some embodiments. As illustrated in FIG. **7**, in order to project the cleaning mixture into the cyclone separator **134**, the cleaning system may comprise a blasting device **168**. The blasting device **168** may receive the cleaning mixture from a separate cleaning mixture source **170** (see FIG. **1**), **170'** (see FIG. **5**), or the neutral media source **164** in some embodiments. The cleaning mixture may be delivered to the cyclone separator **134** via a feed hose **179** (see FIG. **1**), **179'** (see FIG. **5**) via a gravity feed or via agitation and a flow of compressed air as described above with respect to the feed hose **166**, **166'** employed to deliver neutral media to the seed hopper **102**.

As illustrated, the blasting device **168** may be integral with the support member **144**. Thus, in order to clean the cyclone separator **134**, the support member may raise into contact with the cyclone separator using the track **146**. Thereby the blasting device **168** may project the cleaning mixture from an outlet **172** directly into the cyclone separator **134**. For example, the blasting device **168** may project the cleaning mixture using pressurized air. In particular, the feed hose **179**, **179'** may direct a supply of the cleaning mixture into the center of the blasting device **168**, and an air hose **181** (see FIG. **1**), **181'** (see FIG. **5**) may project the cleaning mixture **134** through the outlet **172** into the cyclone separator **134**. For example, the air hose **181**, **181'** may enter through the bottom of the blasting device **168**, and curl downwardly such that an outlet of the air hose is directed downwardly at a surface covered by the cleaning mixture. Thereby, when the air hose **181**, **181'** directed air into the blasting device **168**, the cleaning mixture is propelled through the outlet **172** into the cyclone separator **134**.

As illustrated in FIG. **4**, the cyclone separator **134** may comprise a viewing lens **134***a* which may be used by an operator to ensure that the cleaning mixture has sufficiently removed seed particles from the cyclone separator. In some embodiments the cleaning system may further comprise a vacuum source **174**, as illustrated in FIG. **1**. Thus, the cleaning mixture and any particles from the seeds which are removed from the cyclone separator **134** may be sucked through an inlet **176** (see FIG. **8**) in the support member **144** and out of the apparatus **100** through a vacuum hose **183** (see FIG. **1**), **183'** (see FIG. **5**) by the vacuum source **174**.

The cleaning system may further comprise one or more air jets **178** (see, e.g. FIGS. **3**, **4**, and **8**) configured to direct a pressurized flow of air into the grinder **110** to clean the grinder. FIG. **3** illustrates air jets **178** which direct the pressurized flow of air into the outlet **132** of the grinder **110**. Further, as illustrated in FIGS. **4** and **8**, the air jets **178** may direct the pressurized air into the grinder **110** from the front, back, and top as well as from various other angles as may be understood by one having skill in the art. Thus, the pressurized air may be directed into the grinder **110** to remove any remaining seed particles. For example, the air jets **178** may direct the pressurized air into the grinder **110** before, during and/or after the neutral media is ground by the grinder. Further, the inlet **176** in the support member **144** may be used to suck out any of the seed particles which are removed from the grinder **110** by the pressurized air emitted from the air jets **178**. Thus, the various portions of the cleaning system may work in conjunction to prevent cross-contamination.

In some embodiments the cleaning system may further comprise a negative air flow system configured to direct an ambient air flow generally down and away from the grinder **110** as well as other parts of the apparatus **100**. Accordingly, any seed particles which may enter the air around the apparatus **100** may be removed so as to avoid contamination of the powder prior to installation of the lid **148** on the sample container **142**. As a further cross-contamination measure, the sample container **142** may be configured to store the seeds before the seeds are ground into the powder. In this regard, the sample container **142** may serve to initially store the seeds, receive the powder resulting from grinding the seeds, and mix the powder therein. Therefore, the potential for cross-contamination between successive pluralities of seeds which are ground may be reduced.

Accordingly, embodiments of the apparatus **100** as described above may produce powder from seeds which may be used for testing purposes, for example. Further, embodiments of related methods are also provided herein. In this regard, FIG. **9** illustrates an embodiment of a method for high throughput simultaneous sampling of a plurality of seeds. As illustrated, the method may comprise receiving a first plurality of seeds in a hopper at operation **200**. Further, the method may include metering the first plurality of seeds into a grinder at operation **202**. Additionally, the method may include grinding each of the seeds of the first plurality of seeds in the grinder to produce a powder comprising a plurality of seed particles at operation **204**. Also, the method may include collecting the powder in a sample container at operation **206**. The method may further include selecting a sample portion of the powder for testing at operation **208**. At operation **210** the method may additionally include distributing a neutral media into the grinder. The method may also include grinding the neutral media to substantially prevent cross-contamination with a second plurality of seeds at operation **212**.

In some embodiments the method may additionally or alternatively comprise other operations including those operations illustrated in dashed lines in FIG. **9**. For example, the method may further comprise regulating a maximum dimension of the seed particles exiting the grinder at operation **214**. Additionally, the method may comprise directing a fluid flow through the grinder while grinding the seeds at operation **216**. The method may also comprise separating the seed particles from the fluid flow using a cyclone separator at operation **218**. Further, the method may comprise sealing the sample container at operation **220** and mixing the powder in the sample container at operation **222**. Also, as indicated at operation **224**, mixing the powder may comprise tumbling the sample container. Thereby, as indicated at operation **226**, the method may include mixing the powder to obtain a substantially homogeneous distribution of the seed particles from the seeds within the powder. Further, the method may include testing for presence of a GMO in the sample portion at operation **228**.

The method may additionally include directing an ambient air flow generally down and away from the grinder at operation **230**. Also, the method may include projecting a cleaning mixture into the cyclone separator to clean the cyclone separator at operation **232**. Further, the method may include directing a pressurized flow of air into the grinder to clean the grinder at operation **234**. Accordingly, various embodiments of methods of high throughput simultaneous sampling of a plurality of seeds are provided. Theses methods may be configured to reduce the probability of cross-contamination.

Many modifications and other embodiments of the invention set forth herein will come to mind to one skilled in the art to which these invention pertains having the benefit of the teachings presented in the foregoing descriptions and the associated drawings. Therefore, it is to be understood that the invention is not to be limited to the specific embodiments disclosed and that modifications and other embodiments are intended to be included within the scope of the appended claims. Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation.

That which is claimed:

1. A method for high throughput simultaneous sampling of a plurality of seeds, comprising:

receiving a first plurality of seeds in a hopper;

metering the first plurality of seeds into a grinder;

grinding each of the seeds of the first plurality of seeds in the grinder to produce a powder comprising a plurality of seed particles;

collecting the powder in a sample container;

selecting a sample portion of the powder for testing;

distributing a neutral media into the grinder; and

grinding the neutral media to substantially prevent cross-contamination with a second plurality of seeds.

2. The method of claim **1**, further comprising regulating a maximum dimension of the seed particles exiting the grinder.

3. The method of claim **1**, further comprising mixing the powder to obtain a substantially homogeneous distribution of the seed particles from the seeds within the powder.

4. The method of claim **3** further comprising:

sealing the sample container; and

mixing the powder in the sample container.

5. The method of claim **4**, further comprising tumbling the sample container.

6. The method of claim **1**, further comprising directing a fluid flow through the grinder while grinding the seeds; and

separating the seed particles from the fluid flow using a cyclone separator.

7. The method of claim **1**, further comprising projecting a cleaning mixture into the cyclone separator to clean the cyclone separator.

8. The method of claim **7**, wherein the cleaning mixture comprises the neutral media.

9. The method of claim **1**, further comprising directing an ambient air flow generally down and away from the grinder.

10. The method of claim **1**, further comprising directing a pressurized flow of air into the grinder to clean the grinder.

11. The method of claim **1** further comprising testing for presence of a genetically modified organism in the sample portion.

12. The method of claim **1**, wherein the neutral media comprises a granulated plastic material.

13. The method of claim **1**, wherein the neutral media comprises a plurality of control seeds which do not comprise a genetically modified organism.

14. The method of claim **13**, wherein grinding the neutral media is conducted prior to grinding the seeds of the first plurality of seeds.

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